



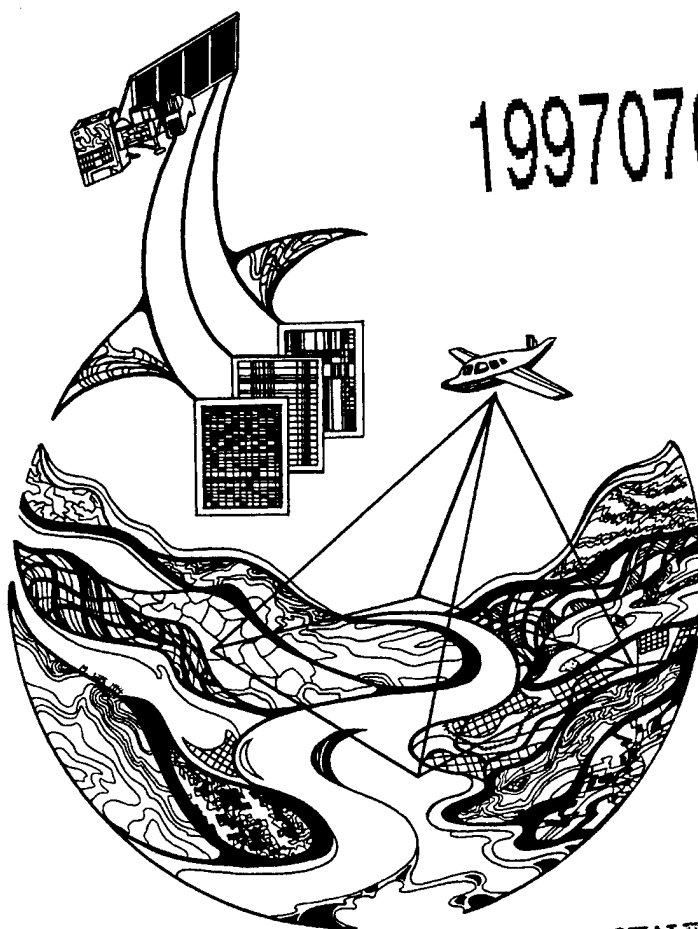
Long Term Resource Monitoring Program

Program Report

95-P008-7

Long Term Resource Monitoring Program
Standard Operating Procedures:

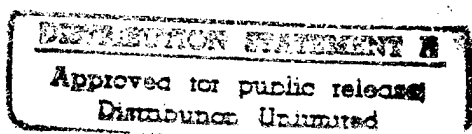
Quality Control for Cartographic Activities



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Long Term Resource Monitoring Program Standard Operating Procedures: Quality Control for Cartographic Activities

by

Thomas W. Owens,¹ Kevin Hop,² Larry Robinson,¹
Lynne DeHaan,² and Tammy Fancher³

¹U.S. Geological Survey
Environmental Management Technical Center
575 Lester Avenue
Onalaska, Wisconsin 54650

²Saint Mary's University of Minnesota
700 Terrace Heights
Winona, Minnesota 55987

³Johnson Controls World Services, Inc.
Midcontinent Ecological Science Center
4512 McMurray Avenue
Fort Collins, Colorado 80525

May 1997

U.S. Geological Survey
Environmental Mangement Technical Center
575 Lester Avenue
Onalaska, Wisconsin 54650

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Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

The strategy to develop and adopt standard operating procedures is included in the LTRMP Operating Plan (USFWS 1993) as strategy 4.1.1, *Develop and Update Information Management Guidance Documents* under Objective 4.1, *Provide Direction for Automation Activities*. This report was developed with funding provided by the Long Term Resource Monitoring Program.

Long Term Resource Monitoring Program Standard Operating Procedures: Quality Control for Cartographic Activities

by

Thomas W. Owens, Kevin Hop, Larry Robinson, Lynne DeHaan, and Tammy Fancher

Abstract

The Environmental Management Technical Center has produced a series of standard operating procedure (SOP) manuals detailing the steps in producing spatial data sets to meet quality standards. The present SOP manual is a continuation of that series detailing the quality control (QC) standards and procedures taken at each production step to ensure that the data are correct and can be passed to the next stage in the production process. Adherence to the SOPs detailed in the other manuals and to the QC procedures discussed here ensure that errors are kept to a minimum and that the data are reliable for monitoring and research.

Introduction

Quality is a "measure of how closely a good or service conforms to specified standards" (Monks 1982) and quality control efforts ensure that the standards are adhered to. In spatial data, quantifiable and nonquantifiable standards must be met. Examples of quantifiable standards include zero errors (e.g., every polygon must have a label), or an error rate less than a certain amount (e.g., a Root Mean Square error [RMSE] of less than 0.005 inches when registering quadrangles on a digitizing tablet). At this time in the technology, nonquantifiable errors include that the polygons represent their position and shape on the ground and the delineation is not overly complex. In addition, the data must be useful for scientific monitoring and research.

The Environmental Management Technical Center (EMTC) has produced a series of standard operating procedure (SOP) manuals detailing the steps in producing spatial data sets to meet these standards (Arndt and Olsen 1995; Owens and Hop 1995a, 1995b; Robinson 1995; Owens and Robinson 1997). The present SOP manual is a continuation of that series, detailing the quality control (QC) procedures taken at each production step to ensure that the data are correct and can be passed to the next stage in the production process. Adherence to the SOPs detailed in the other manuals and to the QC procedures discussed here ensures that errors are kept to a minimum and that the data are reliable for monitoring and research.

Photointerpretation

Quality Standards

- Photo date, flight line number, and pool number should be written on the overlay and the fiducials must be carefully marked.
- All delineations and labels must be neat and legible, clear and concise.
- All delineations must follow ground features based on photographic signatures, but delineations must be drawn simply and not appear overly complex.
- All polygons and linears must be labeled.
- Each polygon must be closed, avoiding dangling segments.
- Each polygon may not have more than one attribute (although there may be multiple labels of the same attribute in large polygons).

- Adjacent polygons must have a different attribute.
- Edge ties must match in all delineations and labels to adjacent interpreted photos.
- Interpretive decisions should be consistent throughout the work and based on visual clues of similar photographic signatures and field notes.

Work on Long Term Resource Monitoring Program (LTRMP) projects is done by different photointerpreters. No two persons will interpret aerial photographs exactly the same way and an individual interpreter will not interpret aerial photographs exactly the same way over time. This creates the need for QC.

The following materials are needed for photointerpretation:

Aerial photographs with interpreted overlays
 Photointerpretation Production Log (Appendix A)
 Field notes from photo verification (Appendix B)
 Mirror stereoscope with light table
 Loupe (magnify $\times 8$)
 Rapidograph drafting pen (4×0)
 Minimum mapping unit guide (Figure)
 Classification list (Appendix C)
 Wooden skewers (for erasing ink)
 Paper (clean white sheet, no lines)

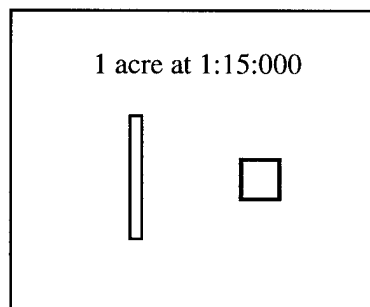


Figure. Example of a minimum mapping unit guide.

The QC reviewer shall be an experienced photointerpreter familiar with the project. Check interpreted work against photointerpretation standards as specified in the Standard Operating Procedures for Field Station Photointerpretation (Owens and Hop 1995a). Make sure that the version of classification used during the review process is the same as that used for the initial interpretation. Review groundtruth notes to become familiar with the vegetation photo signatures (Appendix B). Follow the photointerpreter's comments on the Photointerpretation Production Logs; this will assist with any special problems that the interpreter may have encountered. Make any necessary changes in delineations or labeling by erasing the ink with a wooden skewer and redrawing or labeling with a 4×0 Rapidograph pen using black india ink. Take notes of any consistent errors found during these QC procedures and pass them on to the photointerpreter. This will eliminate future errors of the same nature.

Correctness of Interpretation

Use a mirror stereoscope to review the interpretation of the aerial photograph. Review two components at this stage: (1) correctness in delineations and attributes and (2) consistency in identifying class types, both by delineation and by attributes.

The first component pertains to the correctness of the individual delineation or group of delineations, apart from other delineations. Consider, for example, an island within open water, represented by either one polygon or several integrated polygons: Do the lines follow ground features based on photographic signatures? Should the lines be drawn differently to better represent the area? Is the island labeled correctly according to the photo signature or a specific field note?

The second component compares delineations, attributes, and photo signatures to other interpreted areas, particularly areas that have been groundtruthed. For example, when comparing the interpretation of an island to other interpreted islands in similar situations with similar photographic signatures, are the delineation practices consistent with other areas? Are attributes labeled consistently compared with other areas that have similar photographic signatures and are in a similar situation?

Use a magnifying loupe to identify submergent areas not apparent on the photograph under conventional stereoscopic viewing. Review aquatic areas using the loupe to verify these delineations.

Technical Review

Use a blank piece of white paper to clearly review an interpreted overlay for correctness in delineation and attributing. Place the sheet of paper between the interpreted overlay and the photograph. The line work and labels will show up on the white background of the paper. The following is a brief overview of what to review and correct if needed:

Delineations and labels must be neatly written, legible, clear, and concise. Line work should be of uniform width, as well as consistent (no breaks within the lines). Linears should be represented with an evenly spaced dashed line.

Delineations must be simply drawn, but with enough detail to accurately reflect the ground features. Overly complex detail in delineations is not acceptable.

Polygons must be closed and labels should be placed within the polygon if space allows. If the polygon is so small that the label touches the polygon delineations, the label should be placed outside the polygon with a lead-line into the polygon. Linears must be identified with an arrow from the attribute.

Each polygon may not have more than one attribute assigned to it. Although more than one label may be assigned to large polygons and long linears, the labels must be the same attribute. Each adjacent polygon must have different attributes assigned to it.

Each segment of linears must have a label.

When review of a photo is complete and all corrections and changes have been made, write your initials and date on the interpreted overlay below the photointerpreter's signature (for example, QC-KH, 4/29/96). If the photointerpreter did not sign and date the interpreted overlay, have the interpreter do so. If this is not possible, then write the interpreter's name on the top right corner of the photo and date it according to the

Photointerpretation Production Log. Initial the log to record that the QC is complete for that particular photograph.

When QC is complete for each interpreted photograph, check all edge ties to ensure that delineations match and attributes are the same. To eliminate duplication of effort make the appropriate changes if errors are found; record to assure that all edge ties have been checked. This can be as simple as placing a check mark in the margin of the overlay.

Relay any consistent errors to the photointerpreter to eliminate ongoing errors.

Organize the photographs, making sure that all interpreted overlays are covered with a photo jacket. The interpreted photographs are now ready for transfer. Notify the Senior Photointerpreter that the project is complete. Complete the necessary paperwork and pass the project folder to the Senior Cartographer for transfer.

Zoom Transfer Scope Quality Control

Quality Standards

- Drafted ties must be neat and accurate.
- Complete project information must be listed in the lower right corner of the overlay (quad name and state, project name and year, and other relevant information).
- Line work and attributes must be neat, legible, and properly oriented.
- Each polygon and linear must be uniquely and clearly labeled.
- All edges with data must be precisely tied to the adjacent quad.
- All photos numbers must be labeled on the overlay in red at the approximate center.
- Each quad should be initialed and dated upon completion of QC.

These procedures assume the use of multiple quads for a project's completion. If a project is confined to one quad, some steps will not be necessary. Careful adherence to these procedures will result in a smoother, more efficient flow of cartographic products to the data automation group.

Check that tic marks are present and aligned properly. If necessary, add or redraft tics. Paper topographic maps are susceptible to shrinking and expanding with changes in humidity and temperature. These changes may be small but can make quad registration difficult for the digitizer.

Check for proper labeling of the quad and project name. If unsure of the project name, ask the Senior Cartographer or the geographic information system (GIS) Project Coordinator. The more project information included on the overlay, the easier identification will be if the overlay gets misfiled or separated from the project in the future.

Acquire associated photos with overlays and zoom transfer scope (ZTS) production logs (Appendix D). Compare interpretation line work and labeling with the transferred line work and labeling. If any line work discrepancies are found, note them on the transferred map overlay with red pencil or yellow Post-it Notes. Mislabeled polygons should be changed immediately. If the photo number is not on the quad, write it in red pencil at the photo's approximate center. Once QC is complete for that photo area, put a small red check mark next to the photo number and date the ZTS production log.

After completion of line work and labeling QC, check that all edge ties carried over to adjacent quads are properly labeled. Any discrepancies in edge ties should be brought to the immediate attention of the ZTS operator or Senior Cartographer.

Write initials and date near the quad name and project information in the overlay's lower right corner (for example, QC-LR, 3/3/96).

Bundle and label QC'd quads with the project name and give to the Digitizing Supervisor. Return project quads and photos to their designated storage locations. Notify the Senior Cartographer that the project is complete. Complete the necessary paperwork and pass the project folder to the GIS Project Manager for transfer.

Data Automation

The GIS software used for automation is ARC/INFO and all commands are ARC commands. Digitizing is done using EMTC's Production ARCEDIT (PAE) program, which uses a graphic user interface to guide digitizers through the process (Arndt and Olsen 1995).

Command Explanation

The following ARC commands are used for quality control of data. Refer to ARC documentation for exact usage of these commands. The commands are italicized.

1. *Nodeerrors* with the dangle option

Nodeerrors lists the nodes that are not connected to another feature such as an arc or another node. When the *nodeerrors* command is run with the dangle option, the result should be *Total number of dangling nodes: 0*.

2. *Labelerrors*

Labelerrors lists the polygons that have either zero labels or more than one label. The result of a *labelerrors* should be *Polygon 1 has 0 label points*. Polygon 1 is the outer polygon and should never have a label.

3. *Joinitem*

Joinitem joins two info files on the basis of a common item that exists between the two info files.

4. *Describe*

Describe provides descriptive information on a coverage, such as the number of polygons, the number of labels, the status of topology, the minimum and maximum bounding coordinates, and projection information.

5. *Dissolve*

Dissolve combines adjacent polygons that have the same value or description for a specified item. This command is useful for determining if adjacent polygons have the same attribute.

6. *Statistics*

Generates an INFO data file that lists the unique code occurrences and their statistics. This command is useful for verifying attributes in a coverage.

7. *Frequency*

Generates an INFO data file that lists the unique code occurrences and their statistics. This command is useful for verifying attributes in a coverage.

Quality Standards

- Root Mean Square error must be less than 0.005 inches after quad setup.
- Line work must be smooth, complete, and accurate.
- Every polygon must be closed without any dangles.
- Every polygon must contain one and only one label (except the outer polygon, that contains zero label points).
- Every data feature (point, line, or polygon) must have an acceptable attribute.
- All coverages must have topology and a defined projection.
- Adjacent maps should be tied across map edges.
- After mapjoining, arcs and attributes should match across map edges.

Checking Line Work (by Another Digitizer or GIS Coordinator)

Run a *nodeerrors* on the coverage.

Lay check plots over original digitizing media and compare line work.

Check the plot for missing, inaccurate, or incomplete data. If any white areas show between the digitized arcs and the original arcs, redigitize the arcs.

If the data layer has coincident lines with an existing coverage, compare the two coverages to ensure that coincident lines have been maintained. Visually check each arc in ARCEDIT by bringing the less detailed of the two coverages in as an edit coverage and the other in as a background coverage. For data layers such as a study area boundary coincident with land cover/use, using ARC commands such as *union* will sometimes show where arcs are NOT coincident.

After line work corrections and QC are complete, run another *nodeerrors* on the coverage, and date and initial the Map Information Sheet (Appendix E).

Checking Attributes (by Another Digitizer or GIS Coordinator)

Run a *labelerrors* on the coverage.

Create an area report consisting of a list of the attributes, the frequency, and the area in acres. Check the area report for any attributes that are misspelled, missing, or do not conform to the classification scheme.

A second check plot is created with the attributes displayed. For extremely detailed data where plotting the attributes may not be practical, use the *rplot.aml* that allows you to plot selected attributes (3–5 attributes at a time) in different colors. This also makes it easier to keep track of attribute frequencies. Also check for "empty" attributes, which are labels that have no attributes assigned to them.

Verify the attributes on the check plot with the attributes on the original digitizing media. If there are any discrepancies on the original media, refer to the photos.

As you check the attributes between the two media types, use a third checkoff method with the area reports. As you check attributes on the plot, also check them off on the area report to ensure that the frequency of each attribute is accurate.

Do a *joinitem* with a master lookup table (if necessary) and then go into INFO to again check for any "empty" attributes. If blanks are found, refer to the source media to attribute the feature. After all features are assumed to be attributed, drop the items that were brought over from the first *joinitem* and run the *joinitem* again with the master lookup table. Repeat the process until attributes are complete.

After attribute corrections and QC are complete, generate a final area report and attach it to the back of the Map Information Sheet (Appendix E) as a record of what was done.

Final Quality Control (by GIS Project Coordinator)

Run the *labelerror* and *nodeerror* commands on the coverage.

Do a *describe* on the coverage to check topology and to ensure that the projection has been defined.

Do a *dissolve* on the coverage (if polygonal) as a final check for adjacent polygons with like attributes. If any polygons are dissolved out, refer to the source media. If a problem also exists on the source media, refer to the photos. Make sure that any changes are reflected on the original source media and photos.

If there is more than one coverage, *append* or *mapjoin* the adjacent coverages.

Do a *labelerrors* and a *nodeerrors* on the mapjoined coverage.

Dissolve the mapjoined coverage mainly to check attributes across map edges and check for data that have not been edge-matched properly.

Visually check against another data set in the same location to check the geographic location.

Stereo Zoom Transfer Scope Quality Control

Quality Standards

- Should have five or more control points for every stereo pair.
- Residual error should be less than 5 m except with setups occurring in open water.
- Digitize sufficient vertices for smooth and accurate arcs.
- Line work must be smooth and accurate.
- Every polygon must be closed without any dangles.
- Every polygon must contain one and only one label.
- Every label must contain an acceptable attribute.
- All coverages must have topology and a defined projection.
- Adjacent maps should be tied across map edges.
- After mapjoining, arcs and labels should match across map edges.

Digitizing and Background Coverage Editing

In most instances, Stereo Zoom Transfer quality control (SZTS QC) will be performed by the SZTS Technician upon completion of a stereo pair (and before setup is compromised), after completion of the entire study area, and after completion of the final edit.

Acquire photos with interpreted overlays and compare interpretation to the computer display. Note any digitizing discrepancies and either add, delete, or redigitize as necessary.

After the digitizing and editing of the background coverage are complete, check that the coverage has been properly edge-tied between photos and that each arc is unique. If an arc has been digitized multiple times, determine which line is most accurate and delete all others (it may be necessary to zoom in to determine if there is more than one arc).

Final Coverage Editing

After completion of final editing and labeling by a GIS Technician, obtain a plot of the line work at the same scale as the photography and compare it directly with the interpreted photos. If any changes were made to the line work during digitizing, update the interpretation overlay at this time. Initial and date the additional QC on the overlay.

Once line work is complete, obtain the plot with the labels and compare with the labels on interpreted overlays. If there is a label discrepancy or a change in cover type, height, or density, determine which is correct and update where appropriate. If interpretation is changed, initial and date additional QC on the overlay.

Once all corrections have been made, obtain a summary report and final plot of the line work with labels. Attach both to the SZTS Info Sheet (Appendix F) and file. Return photos to their designated storage location.

Aquatic Areas Quality Control

Quality Standards

- Study area boundary (SAB) and land–water lines must match exactly with the parent land cover/use (LCU) coverage.
- No wing dams or other structures can be in the Main Navigation Channel.
- Line work must be smooth and accurate.
- Every polygon must be closed without any dangles.
- Every polygon must contain only one label.
- Every label must contain an acceptable attribute.
- All coverages must have topology and a defined projection.
- Adjacent maps should be tied across map edges.
- After mapjoining, arcs and labels should match across map edges.

Do a *labelerrors* and a *nodeerrors* on the poolwide coverage.

Do a *describe* on the coverage to check topology and to ensure that the projection has been defined.

Do a *statistics* or *frequency* on the coverage's attribute table to ensure all attributes are legal.

Do a *dissolve* on the coverage as a final check on the attributes. If any polygons are dissolved out, refer to the source coverage. Make sure that any changes are reflected on the original source coverage.

Overlay the aquatic area coverage on top of the parent LCU coverage on-screen in ARCPLOT. Carefully inspect the SAB to make sure that the lines are coincident. Shade the LCU coverage into two colors on the basis of the land–water attribute and overlay the aquatic areas coverage to ensure that all land–water breaks were correctly classified.

Visually check against another data set in the same location to verify the geographic location.

References

- Arndt, L., and D. Olsen. 1995. Long Term Resource Monitoring Program standard operating procedures: Production ARCEDIT digitizing. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, August 1995. LTRMP 95-P008-3. 12 pp. + Appendixes A–K (NTIS #PB95-271136)
- Monks, J. G. 1982. Operations Management, Theory and Problems, 2nd edition. McGraw-Hill Book Company, New York. 725 pp. + Appendixes A–J
- Owens, T., and K. D. Hop. 1995a. Long Term Resource Monitoring Program standard operating procedures: Photointerpretation. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P008-1. 7 pp. + Appendixes A–B (NTIS #PB95-264610)
- Owens, T., and K. D. Hop. 1995b. Long Term Resource Monitoring Program standard operating procedures: Field station photointerpretation. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, August 1995. LTRMP 95-P008-2. 13 pp. + Appendixes A–E (NTIS #PB95-114715)

- Owens, T., and L. Robinson. 1996. Long Term Resource Monitoring Program standard operating procedures: Manual zoom transfer scope. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, December 1996. LTRMP 95-P008-5. 3 pp. + Appendix
- Robinson, L. 1995. Long Term Resource Monitoring Program standard operating procedures: Automated stereo zoom transfer scope. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, November 1995. LTRMP 95-P008-4. 16 pp. (NTIS # PB96-147509)
- U.S. Fish and Wildlife Service. 1993. Operating Plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002R. 179 pp. (NTIS #PB94-160199)

Appendix A. Photointerpretation Production Log

Project:

Total Number Photos:

[illegible]

Appendix B. 1989 Pool 10 Field Verification

Personnel: Kevin Hop
Larry Robinson

Date of Field Verification: August 31, 1994
September 9, 1994

Areas Visited: Just south of L&D 9 and NE of Harper's Ferry, Prairie Du Chien, Pikes Peak Wisconsin River Area, and Guttenburg and North (French Town Lake)

Photos Verified: 49-10, 49-8, 50-6, 50-10, 50-8, on August 31, 1994
52, 10, 52-9, 52-7, 52-5, 50-12, 51-15 on September 9, 1994

Photo Duties Visited: 9-10-89 and 08-30-89

Common Vegetation Seen in Field:

Echinodorus, *Leersia*, *Polygonum*, *Sagittaria*, *Cyperus*, several other grasses and forbs, *Acer*, *Salix*, *Scirpus*, *Nymphaea*, *Nelumbo*, *Sparganium*, *Lemna*, *Anoratus*

Less Common: Cucumber vines, *Ulavus*, *Eliocharis*, *Fraxiens*, *Typha*, *Phalaris*, *Lephalantus*, submergents

Vegetation and water conditions seemed to be upper pool; many sag areas, mud flats, and sag/net/*Nymphaea* areas H₂O and regime, more so in the upper part of the pool. Ex. vegetated signatures of *Sagittaria* proved mud and H₂O in upper part of pool and *Nymphaea*, *Nelumbo* in mid-part of pool. Lower pool proved most consistent in slight variabilities in vegetation on structure. Much of mid-pool showed consistency too. 194 field showed invading spp. of grasses and forbs. *Cyperus*, etam.

Backwater pools tended to be good mixtures of emergent veg., such as spring, *Scirpus*, sag.

Suggestions: Signatures probably consistent in Pool 9. Pool 9 pl first.

Appendix C. LTRMP Vegetation Classification Photointerpreter's List

Version 3.12
5 January 1996

100	Open Water	706	Eleocharis	918	Spartina
101	Lemnaceae	707	Lythrum salicaria	919	Vines as dense overgrowth
102	Azolla	708	Pontederia	920	Polygonum/Eupatorium
		709	Sagittaria	922	Grass/forbs/shrubs
200	Submergents	710	Sagittaria/Lemnaceae	923	Leersia/Phalaris
201	Lemnaceae/submergents	712	Sagittaria/Scirpus/Sparganium	924	Leersia/Phalaris/Polygonum
202	Myriophyllum	713	Sagittaria/Sparganium		
203	Zosterella	714	Scirpus	1000*	Woody Terrestrial
204	Vallisneria/Zosterella	715	Scirpus/Sagittaria	1001	Acer
205	Myriophyllum/Zosterella	716	Scirpus/Sparganium	1002	Acer/Populus and/or Salix
206	Vallisneria/Potamogeton	717	Sedge meadow	1003	Amorpha
207	Myrioph/Potamoget/Vallis	718	Sparganium	1004	Betula
208	Potamoget/Vallis/Zost/Cerat	719	Typha	1005†	Brush
209	Elodea	720	Typha/Sagittaria	1006	Carya/Nyssa
210	Azolla/submergents	721	Typha/Scirpus	1007	Cephalanthus
250	Vallisneria/Potamoget/Heteran	722	Typha/Scirpus/Sparganium	1008	Forest-mesic (moist soil sp.)
251	Ceratophyllum	723	Typha/Sparganium	1009	Forest-upland (dry soil sp.)
252	Lemnaceae/Ceratophyllum	724	Zizania	1010	Fraxinus
253	Lemna/Ceratophyll/Potamogeton	725	Equisetum	1011	Plantation
254	Potamogeton			1012	Populus
255	Vallisneria	727	Scirpus/Zizania	1013	Quercus
		728	Typha/Sagittaria/Scirpus	1014	Salix
300	Submerg-Rooted Floating Aqua	729	Typha/Sagittaria/Sparganium	1015	Salix and/or Populus
301	Brasenia/submergents	730	Typha/Sagittaria/Scirpus/Sparganium	1016	Salix and/or Populus - grass
302	Nelumbo/Nymphaea/submerg/Lemna	731	Typha/Lythrums	1017†	Shrub/grass/forbs
303	Nelumbo/submergents	732	Scirpus/Lythrums	1018†	Shrub/Scirpus
304	Nelumbo/submergents/Lemnaceae			1019	Taxodium
305	Nymphaea/Nelumbo/submergents	800	Emergents-Grasses/Forbs	1020	Taxodium/Nyssa
306	Nymphaea/submergents	801	Leersia/Carex/Polygonum	1021	Ulmus
307	Nymphaea/submergents/Lemnaceae	802	Leersia/Carex/Sagit/Polygonum	1022	Conifers
308	Nymphaea/Myriophyllum	803	Leers/Phalar/Scirp/Lythr/Phrag	1023	Juniperus
309	Nelumbo/Myriophyllum	804	Leersia/Sagittaria	1024	Populus/Acer/Ulmus/Fraxinus community
310	Nelumbo/Nymphaea/Myriophyllum	805	Sagittaria/Phalaris	1025	Quercus/Carya community
311	Nymph/Ceratoph/Myriophyll/Lemna	806	Sagittaria/Polygonum	1026	Salix community
312	Nymphaea/Ceratophyllum/Lemna	807	Sag/Sparg/Typ/Scirp/Leers/Phrag	1027	Populus community
313	Nuphar/submergents	808	Scirpus/Leersia	1028	Salix/Populus community
314	Nuphar/Nymphaeae/submergents	809	Scirpus/Carex/Leersia/Polygon	1029	Quercus/Nyssa/Taxodium community
400	Submerg-Rooted Floating-Emerg	810	Scirpus/Phalaris	1030	Acer/Tilia community
401	Nelum/Nymph/Sag/Sparg/sub/Lemna	811	Scirpus/Phragmites	1031	Upland Forest community
402	Nelum/Nymph/Ponted/sub/Lemna	812	Scirpus/Polygonum	1032	Cephalanthus community
403	Scirpus/Nelumbo/submergents	813	Scirpus/Typha/Phalaris	1033†	Mixed shrubs community
404	Scirpus/Nymphaea/submergents	814	Sparganium/Leersia	1034	Plantation community
405	Zizania/Nymphaea/Nelumbo/sub	815	Typha/grasses/forbs		
406	Pontederia/Nymph/Nelumbo/sub	816	Scirpus/grasses/forbs	1100	Agriculture
407	Sagittaria/Ceratophyllum/Lemnaceae	817	Sagittaria/Scirpus/Leersia		
408	Nelumbo/Sagittaria/submergents	818	Carex/Grasses/Forbs	1200	Urban/Developed
409	Nelumbo/Nymphaeae/Sagittaria/submergents	819	Typha/Lythrums/Phragmites	1201	Developed
410	Nymphaea/Zizania/submergents	820	Lythrums/Grasses/Forbs	1202	Developed parks
500	Rooted Floating Aquatics	821	Sagittaria/Leersia/Polygonum	1203	Industrial pond
501	Brasenia	822	Scirpus/Leersia/Polygonum	1204	Urban
502	Jussiaea	823	Scirpus/Leersia/Phalaris	1205	Revetted bank
503	Nelumbo	824	Typha/Leersia		
504	Nelumbo/Lemnaceae			1300	Sand/Mud
505	Nelumbo/Nymphaea	900	Grasses/Forbs	1301	Mud
506	Nuphar	901	Ambrosia	1303	Sand
507	Nymphaea	902	Grass		
508	Nelumbo/Nymphaea/Lemnaceae	903	Hay meadow	1400	No Coverage
509	Nymphaea/Lemnaceae	904	Pasture (heavily grazed areas)		
		905	Leersia		
600	Rooted Floating Aqua-Emergents	906	Leersia/Polygonum		
601	Nelumbo/Nymphaea/Sagittaria	907	Meadow		
602	Nymphaea/Sagittaria	908	Mixed forbs and/or grasses		
603	Nymphaea/Scirpus	909	Nettles		
604	Sagittaria/Nelumbo	910	Phalaris		
605	Nymphaeae/Zizania	911	Phalaris/Polygonum		
700	Emergents	912	Phragmites		
701	Acoris	913	Phragmites/Phalaris		
702	Carex	914	Polygonum		
703	Cyperus	915	Polygonum/Nelumbo		
704	Decodon	916	Rdside-levee/grass/forbs/shrub		
705	Echinodorus	917	Sand-prairie		

Modifiers:

- A 10-33% Vegetation Cover
- B 34-67% Vegetation Cover
- C 68-90% Vegetation Cover
- D >90% Vegetation Cover

- 1. 0-20 Feet Tall
- 2. 21-50 Feet Tall
- 3. >50 Feet Tall

* Optional Height Modifier Per EMTC Instructions

† No Height Modifier

Appendix D. Zoom Transfer Production Log

Project:

Total Number Photos:

[illegible]

Appendix E. Map Information Sheet

Coverage Name:_____ Date:_____

Project Name:_____ Name:_____

Location:_____ Mapsheet scale:_____

Mapsheet name:_____ Data type:_____

Mapsheet vintage:_____ Theme name:_____

TicId#____ (lon)_____ TicId#____ (lon)_____

(lat)_____ (lat)_____

TicId#____ (lon)_____ TicId#____ (lon)_____

(lat)_____ (lat)_____

TicId#____ (lon)_____ TicId#____ (lon)_____

(lat)_____ (lat)_____

Date of QC line work_____ Initial_____

Date of QC attributes_____ Initial_____

Checked Labelerrors_____

Checked Nodeerrors_____

Fuzzy Tolerance_____

Dangle Tolerance_____

Transformation Errors(if projected)_____

Adjacent Maps for Edge-matching:

Date of Edge-match_____ Initial_____

Date of Mapjoin_____ Initial_____

Appendix F. Stereo ZTS Information Sheet

PROJECT NAME: _____

DIGITIZING

DIRECTORY NAME _____ DATE _____
 SHIFT/DATA SET NAME _____ THEME _____
 LOCATION _____ DIGITIZER _____
 SHIFT X = _____ Y = _____ PAGE _____ OF _____

PHOTO #	<u>PHOTO RESIDUALS</u>			TOTAL
	X	Y	Z	
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

EDITING

EDITOR _____ DATE _____
 LOCATION _____ DATA TYPE: POLY _____ LINE _____ POINT _____

TRACKING

QUALITY CONTROL

TOTAL # ARCS _____ TOTAL # POLYGONS _____ TOTAL ATTRIBUTES _____
 FUZZY TOLERANCE _____ NODE ERR FIXED _____ LABEL ERRORS FIXED _____
 DATE MAP COMPLETED _____ LINE PLOT QC'D _____ ATTRIBUTES QC'D _____
 QC SUPERVISOR _____ TOTAL HOURS TO COMPLETE _____

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